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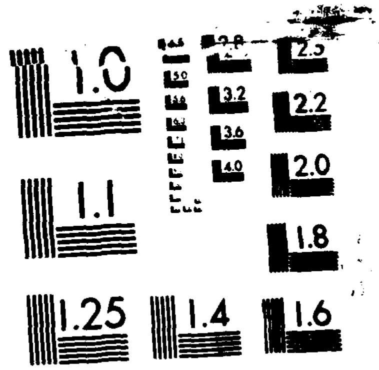

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AIR COMMAND AND STAFF COLLEGE

STUDENT REPORT

USING OPTICAL DISK AS THE STORAGE MEDIA DEVICE FOR THE MASTER PERSONNEL FILES

MAJOR TERRY L. BROOKS 86-0350

"insights into tomorrow"

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DISCLAIMER

REPORT NUMBER 86-0350

TITLE USING OPTICAL DISK AS THE STORAGE MEDIA DEVICE FOR THE MASTER PERSONNEL FILES

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Submitted to the faculty in partial fulfillment of requirements for graduation.

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The growing demand on computer systems warrants research on optical disk technology. This author of this study reviewed current articles/periodicals and determined optical disk systems are the storage media of the future. The computer system environment chosen for analysis was the master personnel files located on the computer mainframe at Headquarters Air Force Military Personnel Center (HQ AFMPC). The analysis found optical disk as a viable storage media for the master personnel files and also recommended additional uses of this media at HQ AFMPC.

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PREFACE

Currently, Headquarters Air Force Military Personnel Center (HQ AFMPC) operates in a labor and operations intensive computer environment, therefore, new systems must continually be analyzed to help keep pace in this ever-changing environment. This study explores the feasibility of using the optical disk system as the storage media for the Master Personnel Files maintained on the HQ AFMPC mainframe computer.

The optical disk storage system represents a relatively new technology in the computer world and recent periodicals indicate it holds great promise for storage of large volumes of data. Several experimental optical disk storage systems are in operation today, and are experiencing good results. Exploring this new computer technology and gaining a working knowledge of this type of system could have a major impact on Air Force computer operations of the future, especially for those systems with extremely large data bases and subject to multiple changes.

The author of this paper has an advanced degree in systems management and over six years experience as a personnel systems analyst. He has contributed to several major personnel system acquisitions (Personnel Support for Contingency Operations, and the Advanced Personnel Data System - II) and is very familiar with the current computer technology. However, because of limitations in the study, the information presented is necessarily general and limited. Further analysis will be required before an actual system change could be made at HQ AFMPC.

In addition this paper is aimed at those individuals who have at least a working level knowledge of computer systems. Therefore, some review of general computer terminology may be necessary before a reader can completely grasp the details of the study.

Finally, the author would like to thank all of the people in HQ AFMPC who helped him gather data and a special thanks to Colonel William O'Conner for sponsoring this project.

ABOUT THE AUTHOR

Major Terry L. Brooks graduated from Clemson University, Clemson, South Carolina, in 1973 with a Bachelor of Science Degree in Ceramic Engineering and was commissioned through AFROTC at the same time. In June 1973, Major Brooks entered Undergraduate Pilot Training (UPT) at Webb AFB, Texas. After graduation, he remained at Webb AFB as a T-38 Instructor Pilot until January 1976. He was next assigned to Ellsworth AFB, South Dakota, as an Executive Support Officer in an aircraft maintenance squadron. Later, he was the Tanker Branch Chief in the 43rd Organizational Maintenance Squadron. In 1978-1979, Major Brooks attended the Air Force Institute of Technology at Wright-Patterson AFB, Ohio, where he received his Master of Science Degree in Systems Management. From 1979 to 1984, Major Brooks was assigned to HQ AFMPC, Randolph AFB, Texas, as a system/requirements analyst for the personnel data system. His responsibilities included the base level Contingency, Operation, Mobility, Planning and Execution System (COMPES); Personnel Support for Contingency Operations (PERSCO); and the Advanced Personnel Data System - II. He left HQ AFMPC for Andersen AFB, Guam, in April 1984 where he served as the Chief of the Consolidated Base Personnel Office until July 1985.

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REPORT NUMBER 86-0350

AUTHOR(S) MAJOR TERRY L. BROOKS, USAF

TITLE USING OPTICAL DISK AS THE STORAGE MEDIA DEVICE FOR THE MASTER PERSONNEL FILES

I. <u>Purpose</u>: The purpose of this study is to analyze the optical disk system, determine the size and number of the master personnel files maintained on the HQ AFMPC mainframe, investigate their associated workload, evaluate the optical disk system with respect to this environment, and develop recommendations to HQ AFMPC based on the findings.

II. <u>Problem</u>: The large number of master personnel files located at HQ AFMPC are maintained in an labor and operations intensive environment.

III. <u>Factors Bearing on the Problem</u>: Within the last year HQ AFMPC has replaced its Burroughs computer systems with the Honeywell systems to improve its personnel data processing capabilities. However, HQ AFMPC is still faced with a monumental task of supporting many different internal and external users. The external users are growing rapidly with new systems such as the Advanced Personnel Data System - II for base level users. This system was designed to provide easy access/retrieval of information. Additionally, HQ AFMPC has over 50,000 tapes of data for support and storage of off-line user activities as well as 17.5 billion characters of on-line storage associated with the master personnel files.

CONTINUED

IV. Conclusion: The author of this study has determined that optical disk systems represent the future technology of storage media devices. The growing demands on the HQ AFMPC systems warrant research of this type to enhance the personnel system's capability and complement the Honeywell systems in the already demanding environment. The author concludes by recommending that HQ AFMPC budget for the acquisition of an optical disk prototype system to futher explore the advantages of this type of storage media device to the HQ AFMPC processing environment. Additionally, there are other applications and areas that should be explored within HQ AFMPC such as the use of the optical disk to replace the numerous paper records, currently placed on microfiche and possible replacement of the bulky on-line storage equipment.

Chapter One

INTRODUCTION

The world around us changes so rapidly that by the time new innovations get to the customer, technology has already changed/improved, and the next evolution of the product is being advertised and consequently shipped to the retailers. The computer environment is certainly no exception.

> During the past 19 years, significant advances have occurred in military-related computers. In terms of hardware, the devices have gotten substantially smaller, lighter, and more powerful with respect to processing, as well as having increased data/program storage capabilities. (35:57)

The development of the optical disk as a media storage device represents another generation of mass storage.

> In the United States alone, about 600 million pages of computer printouts, 235 million photocopies, and 76 million letters are produced each day. To meet the challenge of this information explosion, several companies are devising disks no larger than a long-playing record, that will allow users to store a huge amount of data in a small amount of space. (5:33)

> The optical disk (storage media) can store (an estimated) 10 to-the-tenth bits - equivalent to the number of neutrons in a typical person's brain, two-thirds the distance to the moon in inches, or the number of seconds in 317 years. (27:74,76)

The Director of Personnel Data Systems (DPMD), Headquarters Air Force Military Personnel Center (HQ AFMPC), Randolph AFB, Texas, is the single manager for Air Force personnel data systems. Specifically, DPMD is tasked to update and store personnel information on active duty and retired Air Force, Air National Guard, Air Force Reserve, and Department of the Air Force civilian personnel. This accounts for almost two million computerized master personnel records. To accomplish this tasking, HQ AFMPC requires one of the largest computer systems in the Department of Defense. Update transactions for this system

flow to HQ AFMPC from the Air Staff, the National Guard Bureau, the Headquarters Air Reserve Personnel Center, the Air Force major commands (MAJCOMs), their respective bases, Separate Operating Agencies (SOAs), and the recruiting and technical training missions of Air Training Command. Other activities include providing support for all personnel divisions within HQ AFMPC and the development efforts for the personnel data system at base and MAJCOM levels. These requirements have been expanded many times during the past, and it appears that the system will require as much or more expansion in the future. During the last year for example, HQ AFMPC has undergone a computer replacement program in an attempt to maintain this fast pace.

This study will analyze the possibility of using an optical disk system for storage of the Master Personnel Files (MPFs), based on the current number and projected growth of those files in both size and quantity. It will also examine the times directly associated with MPF processing. The results of this analysis will be used to make a recommendation to HQ AFMPC on whether to pursue optical disk storage - one of the media systems of the future.

RESEARCH HYPOTHESIS

This study is an analysis of the optical disk system and the potential benefits associated with using such a system at HQ AFMPC. Currently, there are approximately "30 companies developing optical disk systems. These include the giants such as IBM, Xerox with Thomson-CSF, Eastman Kodak, and RCA as well as Toshiba, Matsushita, and Hitachi in Japan." (10:48) The purpose of this study is to identify the advantages and disadvantages of optical disk systems through analysis of recent periodicals in education, business, and science and technology to determine if optical disk storage is, in fact, a viable storage media for HQ AFMPC. A separate analysis of the size and number of MPFs, plus projected growth to include storage/retrieval time requirements associated with them, will be conducted through the use of interview/testimony of key HQ AFMPC systems personnel. This study will also include an evaluation of the optical disk as a mass storage device for the MPFs, and conclude with a recommendation to HQ AFMPC on the feasibility of using an optical disk system in the HQ AFMPC environment.

RESEARCH OBJECTIVES

The feasibility of using an optical disk system at HQ AFMPC will be analyzed through the review of five research objectives:

1. Investigate the capability and efficiency of the optical disk as a storage media device.

2. Determine the size of the MPFs and the number maintained on the HQ AFMPC mainframe computer, plus the projected growth rate of both.

3. Investigate the workload associated with maintaining the MPFs, specifically storage and retrieval in terms of processing times.

4. Evaluate the use of the optical disk as the storage media device for the MPFs.

5. Develop recommendation(s) based on the capability of an optical disk storage system to accommodate the MPFs.

METHODOLOGY

Every effort was made to use the most current periodicals. The author visited HQ AFMPC and discussed/analyzed the MPF requirements with the personnel data system experts. The basic data and predictions are fully explained in the text to assist with any further analysis HQ AFMPC may wish to conduct.

ASSUMPTIONS AND LIMITATIONS

Several assumptions were made to simplify the analysis of this study. First, the analysis of the optical disk system does not include any direct contacts with vendors, preventing consideration of any recent breakthroughs in optical disk technology. Second, the growth rate of the MPFs is based on historical data and current systems development initiatives.

Some aspects of this study were not fully developed, due to limits on the resources available to conduct the analysis. In particular, the cost of the optical disk system will not be considered in the analysis. This aspect could not be viewed as a variable for consideration because this study does not include actual requests for bids from potential vendors. Multiple environments were not analyzed because of the time constraints associated with the project. Except for these limitations, the data was as accurate as possible and provided, in the author's opinion, a valid means of assessment.

Chapter Two

EVALUATION OF OPTICAL DISKS

The purpose of this chapter is to evaluate the efficiency of the optical disk as a storage media device. Current and historical periodicals were reviewed and analyzed to make this final assessment.

BACKGROUND

Basically, the optical disk system entails using a laser to code information in the form of microscopic pits, bubbles, or air pockets on a reflective information (disk) surface. (13:862) A tightly-focused laser beam is used to accomplish the process. The laser beam affects the surface by visibly producing a change in the area it strikes, resulting in the pit, bubble, or air pocket. A continuous laser beam is used to scan the affected area, and the reflected light produces frequency-modulated signals consisting of varying lengths dependent on the size of the deformation in the disk surface. This signal, when interpreted, holds the information stored on the disk. (14:62) Optical disk technology, more than a decade old, will be discussed in the next section. Before going on to the types of materials and processes currently in use, a brief look at the history of the optical disk systems will be given.

Research and development of a new type of storage media device is not something new to the 1980s. Stanford Ovskinsky was the original pioneer for optical disk technology, which he developed in 1960. (29:64,94) By the next decade, the impact of this technology was already being felt. The following quotes are predictions made in the early 1970s:

> Precision Instrument Company, Palo Alto, landed a second order for its trillion-bit laser recorder/reader storage system last month and said it will market a smaller 10 million-bit version. (26:117)

> Lower component costs are being credited in price cuts for a read-only optical memory system announced only a year ago. A 25% drop, to 3 cents per bit for a 100 thousand-bit model in quantities of 100, is due this month from Optical Memory Systems, Santa Ana,

California. Prices will get down to a penny a bit 2 years from now. (21:20)

> Holographic memory systems with capabilities in the 10 trillion-bit range and microsecond speeds have long been talked about. They're still in the lab. But next month, first units of a holographic system are scheduled to be shipped to a new firm, Optical Data Systems, Mountain View, California, for field testing. (22:7)

The 1970s were not nearly as prosperous for optical disks as originally projected. Quite frankly, it was a total bust from an industry standpoint. The "glowing promises for optical memories turned out to be little more than that" (24:30) resulting in many of the early companies either folding or diverting their attention to other areas.

Although the manufacturers of optical disk systems experienced many trials and tribulations through approximately two decades of research and development both in the U.S. and overseas (Europe and Japan, primarily), customers are now using optical disks in an assortment of capacities. Ultimately, the introduction of the optical disk system as a mass storage device represented a quantum leap for storage media and the computer industry. (30:215) With this quick look at the history of the optical disk systems, we can now proceed with the technical details of today's systems.

MATERIALS USED/EMBEDDING INFORMATION PROCESS

The optical disk looks very similar to the common phonograph record but is composed of a material that undergoes an embedding process to place the information on the disk. Three different materials are used by current manufacturers, and three different processes are used to place the information on the disk. A discussion of the types of materials used for optical disks will be followed by an overview of the current embedding processes. Before looking at the embedding process currently in use, we will focus on the basic materials used in today's systems.

MATERIALS USED

Industry basically uses three types of material for optical disks - tellurium (Ti), silver halide, and gold/platinum alloys. Numerous articles indicate that approximately 70% of the manufacturers use the non-metallic element of tellurium. This substance resembles sulfur and selenium in chemical properties. Tellurium is favored for its low melting point of 450 degrees Celcius. Unfortunately, Ti has two undesirable characteristics. It oxidizes rapidly when in contact with moisture, and it causes

people who are in direct contact with the material to have a bad body order. These characteristics result in several drawbacks for the optical disk industry.

Consequently, considerable research has been done on Ti in an attempt to coat it, alloy it with another more stable element, or use it in some type of layering technique to preclude oxidation and direct human contact. American and Japanese companies pursued the use of tellurium/tellurium oxide, while the French selected a gold/platinum alloy. The Drexler Technology Corporation chose silver halide and was successful in producing the first commercially available disk. In order to produce a disk from silver halide, Drexler had to overcome the problems of processing and the substance characteristic of graininess. (31:86,88,97)

Regardless of the choice of material for the composition of the disk, the literature indicates manufacturers are producing each type today with varying degrees of success. The production of the optical disk represented the first hurdle in developing it as a storage media device. Now for the second hurdle, the various processes used to store the information on the disk.

EMBEDDING INFORMATION PROCESSES

Three different techniques for embedding information on optical disks are employed today. These are ablative, bubble or blister, and tri-layer. The ablative technique burns holes or pits into the disk surface. The bubble or blister method uses a layer of polymer under the medium. Through interaction with the laser, a pocket of gas is formed underneath the polymer layer, resulting in a bubble or blister effect. The surface of the disk is similar to those processed through the ablative technique. The data on disks using either the ablative or bubble method is read by focusing the low power laser on the recording track of the disk. When the laser's light passes over those portions of the track without either a pit, bubble or blister, the light is reflected to the surface which actually scatters the light. The reading of the data occurs when a concentrated beam is reflected from an area on the track with the pits or bubbles.

The tri-layer incorporates a refracting layer, a spacing layer, and an absorbing layer within the media. Specifically, the laser heats the disk and actually changes the absorption and refractive properties of the layers. The disk is read by passing a laser over these changes in the properties of the disk media. The reflected light is again the key to interpreting the data on the disk. Because the surface of the disk can be harmed, protective coatings can be applied to the optical disk surface to keep the surface free from scratches or dust. (11:225-228)

These different materials and embedding processes represent current optical disk technology. Each has its advantages and disadvantages which are closely related to the type of data to be stored and the environment for which the system is designed.

OPTICAL DISK CAPABILITIES

The user must understand the capabilities of the optical disk systems before the possibility of implementation can be evaluated. Currently, optical disk have three different capabilities: read-only, read-write, and erasable. (9:68)

Read-only disks are created by using a process referred to as mastering. The manufacturer creates the master copy of the disk and stamps out copies for sale to the user. (36:48) "The first commercial optical disks were read-only." (12:65)

The read-only disk has two formats for optical disk storage. These include optical video disks and the compact disk read-only memory (CD-ROM). These formats, although similar, are different with respect to application. The optical video disk, the most widely used, stores unique analog images such as photographs, slides, and film segments. The newest innovation in optical video disks is the ability to digitize the images, place them in a buffer, and reformat the data. The disk's broadest application is to training activities, which will be covered later in the chapter.

The CD-ROM has revolutionized data retrieval for the office environment. It was first introduced as an audio disk for compact disk players, which are expected to eventually replace the stereo turntable. A recent breakthrough in technology resulted in digitized information being placed on the CD-ROM. This discovery should positively affect the trend to move away from large centralized computer systems. (15:48,49,70)

Another difference between the optical video disk and the CD-ROM is the size of the disks (12 inches in diameter for video disk and 5 inches in diameter for the CD-ROM).

Read-write disks are created in the user environment with a process similar to that used for creating the master disk for read-only. (36:48) The read-write disk can be recorded to with built-in lasers which change the surface of the disk as the information goes on. (9:68) Another name for this capability is direct-read-after-write (DRAW). (30:224) An advantage of this process is the error detection device in the recorder, which compares the information written with the original data. (10:49)

The third capability, and the biggest breakthrough for the industry, was the erasable disk. Erasable disks allow repetitive

storage of information on the same disk similar to storage on magnetic tape, floppy disks, and hard disks. Reheating spots on the disk erases information by rearranging the particles. Currently, several companies have demonstrated this capability. (36:49) In 1983, Matsushita introduced this new technology at a computer convention. A Matsushita official was quoted as saying, "No kidding, it (the information on the disk) is really gone." (8:110) The erasable disk was released commercially in 1985 by the 3M Corporation. (6:100)

These three capabilities exist in the optical disk market today. The section on commercial product releases in this chapter list several of these products.

ADVANTAGES/DISADVANTAGES OF OPTICAL DISKS

Optical disks have advantages and disadvantages, which will be covered in the following section.

ADVANTAGES OF OPTICAL DISKS

In order to explore the advantages of the optical disk as a storage media device, the major disadvantages of other types of current storage media (hard disk, floppy disk, and magnetic tape) must be reviewed. These media result in an operationally intensive environment with time delays for frequent loading of off-line data. On-line data must be backed up because of the susceptibility of error for magnetic media. Also, storage of this media requires extensive amounts of valuable office space. (36:48)

The primary advantage of optical disks as a storage media device is their denser storage capability. Optical disks have approximately 10-100 times greater storage capability than magnetic tape (10:47), more than four times the image density of standard microfiche or microform with five times the resolution (34:88), and more than 17 times the area density of the high capacity Winchester hard disk. (20:277)

Other advantages include ease in handling/removing optical disks; maintenance of archival information without degradation for more than 10 years; and data integrity guaranteed with the read-only disk because the information is being stored below the surface free from scratches, smudges, and fingerprints. (36:48,52) Optical disks also have the capability to store all forms of data -- audio, video, and digital. (35:12) They have an extremely low error rate (13:864), are not effected by moisture, and do not undergo chemical deterioration. (28:76) The embedding process also requires substantially lower power consumption. (19:157) Additionally, optical disks can record and instantly play back information (10:47); have a lower cost in replication

and distribution (36:52); have high signal-to-noise ratio and low thermal conductivity; and their manufacturing process is free of toxic substances. (31:88,99)

Another major advantage lies in the area of training, with the emphasis on training methodology. Interactive video disk training represents a new era in on-the-job training, especially in the office environment. Training courses can eliminate the instructor due to "the computer associated instruction, combining the best features of the instructor led classes and self-paced user manuals." (25:72) Computer video disk training results in cost savings which are sizeable, since the organization becomes self-sufficient in training while continuing to meet its diverse needs. (25:72) The Butterfield Group, Cambridge, Mass., identified four primary areas where this type training could be applied: (1) training service technicians on the service and repair of products, (2) marketing products for sales managers, (3) training employees and customers on the use of equipment, and (4) general skills training. (12:49)

The advantages of optical disks are numerous and significant, but the systems have some disadvantages, too, and those will be discussed next.

DISADVANTAGES OF OPTICAL DISKS

Optical disk technology, although very impressive, has several disadvantages. These disadvantages are the primary interest of current research and development efforts for optical disks. The need to develop user friendly menus for the complex filing and indexing of data for the individual user's system has posed several problems. The lack of applications software results in the inability to integrate the storage system with the framework of the corporate information system. (36:48)

Other disadvantages include the slow writing (2:45) and retrieval speed (6:100) of current commercial systems. Also, the cost of making corrections due to errors is higher than magnetic storage media. The optical disk detection and correction process uses approximately 50 percent of the disk platter memory capability and directly impacts on the cost for high volume users. (18:12) But, it is the lack of standardization that causes the greatest concern for the user.

Although several companies are meeting regularly to discuss standardization, the simplest problem of determining the disk size remains open. Manufacturers produce disks with diameters of 14, 12, 8, 5 1/4, 3, and 2 inches. Additional standardization problems include the stability and integrity of data, as well as producibility of the media. (31:86) Finally, Japanese manufacturers are advancing so rapidly with optical disk

technology that incompatibility with the current computer market causes indecisiveness on the part of the user. (12:45.46)

Numerous references in periodicals indicate that many of the major optical disk manufacturers are working steadily to solve these problems, and have arrived at some solutions in the laboratory environment.

USES OF OPTICAL DISKS

Originally, the most attractive feature of optical disks as a storage media device was the tremendous amount of storage capability of these disks. However, manufacturers have identified a wide spectrum of uses for optical disks. Storage media have many uses, including archival storage with both structured and unstructured data bases. (12:66) Specific applications include storage of legal opinions, medical research/history, periodical abstracts, bibliographies (33:234), and military satellite imagery. (35:61) Other uses are electronic mail, voice storage and forward applications (12:69); local-area-network file servers, electronic publishing, information utilities, and graphic storage. (32:42) Furthermore, the optical disk provides a permanent audit trail for financial transactions; records keeping to include warranty records, inventory records, point-of-sales transactions, credit records for verification, and training records (discussed earlier in the Advantages of Optical Disk section). (15:70,71)

Many agencies have exhibited an interest in optical disks. In general, government agencies are interested in optical disk media because it offers a greater shelf life for material storage. (36:49) Government agencies currently using optical disk systems include the Army Corps of Engineers - for storage of engineering drawings, NASA - for storage of data transmitted from satellites, the Library of Congress - for more than 500,000 volumes (7:39), and the National Agricultural Library - for storing and disseminating agricultural information. (1:139) These examples, although not all-inclusive, indicate the vast capabilities of optical disk systems and their user attractiveness.

COMMERCIAL PRODUCT RELEASES

There are many optical disk systems available commercially. The following examples are representative of the types of storage media currently on the market.

Information Storage, Inc, produces a read-write 5 1/4 inch optical disk with a 100 megabyte storage capacity. The company also produces the Model 525 WC disk drive, which features a

transfer rate of 2.5 million bits per second and an average access time of 200 milliseconds. (17:35)

Hitachi, Inc., produces the Model H68975-1, designed for its 12-inch optical disk with a storage capacity of 1.3 gigabytes per side. They also market the Model H-68975-A1, an optical disk drive in a multi-disk configuration which accommodates 16 disks and stores 46 gigabytes, as well as the Model H-6975-A2 disk drive which handles a maximum of 32 disks and stores 84 gigabytes. (16:57)

Reference Technology, Inc., released commercially the CLASIX optical disk drive with a transfer rate of one megabyte per second and an average access time of 151 milliseconds with an average seek time of 125 milliseconds. The optical disk marketed for this system has a storage capacity of one gigabyte per side. (23:418,419)

The 3M Corporation developed/released an optical disk that can be used to move, change, and erase data. The 5 1/4-inch disk holds up to 250,000 pages of text. (6:100)

These impressive examples of commercial products are illustrative of the current optical disk systems available on the market today, but what the future holds may be even more impressive.

OPTICAL DISK PREDICTIONS

Predictions for the future development of optical disk systems indicate a very positive outlook with respect to cost/sales, materials, storage capacity, and the much needed index system. There seems to no longer be a question of user acceptance of optical disk systems. "Optical Disk Storage Outlook", by Freeman Associates, predicts worldwide shipments totalling 2.4 million with revenues to reach $4 billion in 1987 and $7 billion in 1990. (32:42) Edward S. Rothchild, chairman of Rothchild Consultants - a firm specializing in offering consulting services, conferences, and research studies in optical memory - is more of an optimist, and predicts sales will reach closer to $11 billion in 1990. (6:100) Research and development will continue in the exploration of new disk materials, with emphasis on polymer/dye. (31:104) Storage capacity is a continuing interest item. Predictions indicate that commercial storage will reach the gigabyte plus level (4:24) with concentration not on just more storage capacity but on storage of more appropriate and meaningful data. (15:72) Again, the biggest problems optical disk developers face are the lack of standardization and a file index system for this massive new storage capability. More companies are concentrating their

efforts on these problems, with emphasis on standardization, and the efficiency and effectiveness of retrieval. (3:94)

SUMMARY

The future looks good for optical disks. Their early acceptance in the 1980s inspired manufacturers to continue their research and development efforts. This extensive and exhaustive periodical review of optical disk technology indicates that optical disks are a viable storage media. The advantages outweigh the disadvantages, primarily because each disadvantage has already been overcome in the test environment. These systems should be commercially available by the early 1990s. The bottom-line is that the literature confirms this technology is here to stay. But what does optical disk technology mean to the Air Force, and specifically, to the maintenance of MPFs by HQ AFMPC?

Chapter Three

SPECIFICATIONS OF THE MASTER PERSONNEL FILES

The purpose of this chapter is to determine the type, size, number, and projected growth rate of the Master Personnel Files (MPFs) maintained on the HQ AFMPC mainframe computer. The workload associated with maintaining the MPFs - specifically storage and retrieval activity in terms of processing times - was also investigated. The bulk of this information was collected between 23 and 27 December 1985, to ensure that the information was as accurate and up-to-date as possible.

MPF - TYPE, SIZE, NUMBER, AND PROJECTED GROWTH RATE

A number of individuals were interviewed and reports reviewed within HQ AFMPC/DPMD to determine the specific characteristics of MPFs to include the type, size, number, and projected growth rate of each. A summary of this information can be found in Table 1, with the exception of the projected growth rates of MPFs. The projected growth rate was difficult to determine, but system experts estimate that the current type, size, and number of MPFs are adequate to support future projected operations for Air Force active duty, Guard, Reserve, civilian, and retired personnel, particularly in light of possible future personnel cuts due to the Gramm-Rudman Bill. (37:XX)

MPF - PROCESSING TIMES

Processing times associated with MPFs were determined through interviews and the review of reports. Table 2 represents the actual processing time schedule for MPFs update for 5 January - 8 February 1986, and indicates that MPFs are updated on a daily basis. Table 3 is the actual processing times associated with certain MPF transactions 3 - 14 September 1985. The average number of MPF transactions per month for 1985 was 4.7 million incoming and 5.8 million out-going for an estimated total of 123 million. The month of December 1985 had not been completed when this information was obtained, and is not included in the calculations. These transactions required approximately 50 percent of the available processing time on the HQ AFMPC mainframe computer. (37:XX) These numbers certainly indicate the tremendous processing requirements for MPFs.

SUMMARY

The HQ AFMPC charter to support and maintain information on the active duty, Guard, Reserve, civilian, and retired military personnel results in a large processing requirement. The latest upgrade (1984) of the HQ AFMPC mainframe is indicative of this large processing requirement. The need for timely processing of MPF information has expanded rapidly in the last few years. (37:XX) This need will be described in more detail in Chapter Four.

MASTER PERSONNEL FILES CLEARTEXT	FILENAME	INACTIVE	TYPE ACTIVE	TOTAL	SIZE (CHAR)	TOTAL * SIZE
ACTIVE AMN	AA	21,224	488,597	509,821	5,040	2.5695B
ACTIVE OFF	BA	6,251	106,442	112,693	6,300	.7100B
GUARD AMN	AG	3,677	92,136	95,813	2,700	.2587B
GUARD OFF	BG	301	12,680	12,981	4,680	.0061B
RESERVE AMN	AR	5,056	105,704	110,760	2,880	.3190B
RESERVE OFF	BR	11,112	122,951	134,063	5,400	.7239B
RETIRED AMN	RA	0	429,437	429,437	420	.1804B
RETIRED OFF	RB	0	172,127	172,127	480	.0083B
ACTIVE CIV	CA	0	297,996	297,996	8,280	2.4674B
CIV HISTORY	CH	0	185,510	185,510	8,280	1.5360B
CIV TNG QUOTAS	CQ	0	44,416	44,416	360	.0016B
CIV HIST TRACK	CJ	0	446,929	446,929	9,000	4.0224B
ACTIVE OFF JOB FILE	BE	0	147,931	147,931	660	.0098B
PCARS	GR	0	194,961	194,961	2,700	.5264B
MANDAYS	GM	0	224,420	224,420	168	.0038B
AWARDS/BCMR	HC	0	32,753	32,753	9,540	.3125B
PRIVACY ACT	PR	0	381,150	381,150	8,280	3.1559B
PAS	PP	0	11,891	11,891	564	.0007B
SUGGESTION PROG	SG	0	254,348	254,348	2,880	.7325B
	TOTAL NUMBER OF CHARACTERS OF STORAGE					17.5449B

TABLE 1 (37:XX)

MASTER PERSONNEL FILES STORED AT HQ AFMPC

* Calculated by multiplying total number of MPFs in a particular category by the size (number of characters) in the record.

DATE	FILENAME	DATE	FILENAME	DATE	FILENAME
5 JAN	PAS	17 JAN	AA,AG,AR CA,HC,BG BR	29 JAN	AA,GM,HC CA,PAS
6 JAN	AA,BA,CA HC	18 JAN	BA,GR,GM	30 JAN	BA,AG,AR SG,BA,BG BR,PR,CJ HC
7 JAN	AG,AR,AA CQ,BG,BR HC,CH	19 JAN	PAS	31 JAN	HC,AG,BR AA,BG,HC CA,AR
8 JAN	AA,GM,HC CA,PAS	20 JAN	AA,BA,CA HC	1 FEB	BA,GR,GM
9 JAN	BA,AG,SG HC,BG,PR CJ,AR,BR	21 JAN	AG,AR,AA CQ,BG,BR HC,CH	2 FEB	PAS
10 JAN	AA,AG,AR CA,HC,BG,BR	22 JAN	AA,GM,HC CA,PAS	3 FEB	AA,BA,CA HC
11 JAN	BA,GR,RA BE,CA,GM RB	23 JAN	AG,AR,BA CJ,SG,BG BR,HC,PR	4 FEB	AG,AR,AA CQ,BG,BR HC,CH
12 JAN	PAS	24 JAN	AA,AG,AR CA,HC,BG,BR	5 FEB	AA,GM,HC CA,PAS
13 JAN	AA,BA,CA HC	25 JAN	BA,GR,RA RB,BE,GM	6 FEB	BA,AG,AR SG,HC,BG BR,PR,CJ
14 JAN	AG,AR,AA CQ,BG,BR CH,HC	26 JAN	PAS	7 FEB	AA,AG,AR CA,HC,BG BR
15 JAN	AA,GM,HC CA,PAS	27 JAN	AA,BA,CA HC	8 FEB	AA,BA,GR RA,BE,RB GM
16 JAN	BA,AG,AR HC,SG,BG BR,CJ,PR	28 JAN	AG,AR,AA CQ,BG,BR HC,CH		

TABLE 2 (37:XX)
MASTER PERSONNEL FILES UPDATE SCHEDULE (5 JAN - 8 FEB 1986)

FILENAME	DATE(1985)	LAPSE TIME(HR)	PROCESSING TIME(HR)
AA	3 SEP	13.040	3.760
	6 SEP	14.800	4.510
	9 SEP	15.864	5.263
	10 SEP	7.292	3.799
	11 SEP	14.636	4.639
	13 SEP	19.719	4.888
BA	5 SEP	10.571	7.794
	7 SEP	3.275	1.411
	9 SEP	8.945	3.124
	12 SEP	7.928	0.579
	14 SEP	3.671	1.492
AG	3 SEP	3.307	0.315
	5 SEP	2.470	0.315
	6 SEP	1.711	0.437
	10 SEP	0.805	0.479
	12 SEP	2.297	0.335
	13 SEP	1.513	0.444
BG	3 SEP	2.644	0.129
	5 SEP	1.508	0.201
	6 SEP	1.069	0.155
	10 SEP	1.183	0.155
	12 SEP	1.335	0.055
	13 SEP	1.010	0.161
AR	3 SEP	5.338	0.274
	5 SEP	1.508	1.600
	6 SEP	1.848	0.520
	10 SEP	2.961	0.537
	12 SEP	2.449	0.359
	13 SEP	1.608	0.603
BR	3 SEP	2.644	0.364
	5 SEP	3.875	1.810
	6 SEP	2.798	1.342
	10 SEP	1.609	0.309
	12 SEP	1.286	0.169
	13 SEP	2.707	1.485

TABLE 3 (37:XX)
RUN TIMES FOR MASTER PERSONNEL FILE UPDATES

Chapter Four

EVALUATION OF THE OPTICAL DISK SYSTEM

The purpose of this chapter is to evaluate the optical disk system as a media storage device for the MPFs located at HQ AFMPC. As indicated by the analysis of the MPFs in Chapter Three and the associated problems with volume, MPFs require a sizeable storage media. Before this evaluation can be finalized, the perceived computer problems at HQ AFMPC and the Center's current storage media must be explored in detail.

HQ AFMPC - STORAGE MEDIA PROBLEMS?

The obvious questions are, does the growth rate and the large number of records warrant a different storage media device such as the optical system, and would there be benefits associated with this type of change in storage media devices? These questions are addressed in this evaluation, but first, the study will concentrate on perceived processing problems and the efforts made by HQ AFMPC to solve those problems.

Within the last year HQ AFMPC has replaced its Burroughs computer systems with the Honeywell systems to improve its personnel data processing capabilities. Even with the computer replacement, HQ AFMPC is still faced with the monumental task of supporting many different internal and external users. External user requirements are growing rapidly with the addition of the Advanced Personnel Data System - II (APDS-II) - the new base level system. (37:XX) A further description of this system and its associated processing requirements will be discussed later in this chapter.

The Honeywell systems currently operate 24 hours a day, seven days a week. As previously pointed out in Chapter Three, MPF processing requires approximately 50 percent of the processing time on the HQ AFMPC mainframe computer, and is considered to be very operations intensive. But, the system is also saturated with requests from other users (both on-line and off-line), including the active duty, Guard, and Reserve bases; the MAJCOMs and their respective Numbered Air Forces; the Air National Guard State Headquarters; the Air Reserve Personnel Center; numerous users within the building including the assignment sections for both officers and airmen; the HQ Air Force Wartime Manpower and Personnel Readiness Team (AFWMPRT); and HQ USAF. (37:XX)

The external users are also expanding in number, as previously alluded to, with the advent of APDS-II. This new system brings many new on-line users to the HQ AFMPC computer environment. Specifically, APDS-II is a base level/selected user system. The advantage of APDS-II is to give these new users the ability to go on-line to the HQ AFMPC mainframe computer for purposes of inquiry. This new capability directly impacts the processing times of the system at HQ AFMPC. These new on-line users include all active duty base personnel offices, base manpower offices, base civilian personnel offices, Air National Guard State Headquarters, Reserve base personnel offices, and the Numbered Air Forces of each MAJCOM, or their equivalents such as the Product Divisions within AFSC. APDS-II equipment is being installed with the completion of the conversion scheduled for April 1987. Connection of the APDS-II equipment with the HQ AFMPC computers is expected to start the summer of 1986. The impact of APDS-II will be concentrated in the area of processing MPF inquiries. As noted in Chapter Three, the inquiries currently against the MPFs are greater than 123 million per year. (37:XX)

In addition, each of the APDS-II users will have the capability to communicate with any terminal connected to the HQ AFMPC mainframe computer. For example, the Consolidated Base Personnel Office (CBPO) at Maxwell AFB, Alabama, will be able to communicate directly with a terminal in the CBPO at Andersen AFB, Guam. The communications software for this capability resides on the HQ AFMPC mainframe computer, and its use will require additional processing time. Other systems are also being developed at HQ AFMPC, such as the CBPO of the Future (PC3), which will add even more users to this environment. (37:XX) These on-line user requirements will indirectly affect the off-line storage requirements.

Currently, HQ AFMPC has over 50,000 tapes of data to support and store off-line user activities. Approximately 10 percent of this information is active duty backup files, and the residual 90 percent is archieval/history files such as end-of-month, end-of-quarter, and end-of-year processing. Again, the majority of this information deals directly with MPF transactions. (37:XX)

The last few paragraphs have presented an expanded picture of the current and future requirements HQ AFMPC must be prepared to handle. These problems present a definite challenge for the future of the HQ AFMPC information processing environment.

OPTICAL DISKS FOR HQ AFMPC?

Current data on the optical disk system as a storage media device was reviewed in Chapter Two. The findings certainly

indicated that the optical disk system represents the current and future technology for storage media. The primary advantages of the optical disk systems are a denser capability; ease in handling/removing media; lower susceptibility to damage with an expected life of over 10 years unlike magnetic storage media; guaranteed data integrity; the capability to store all forms of data including audio, video, and digital; low error rates; the ability to withstand moisture or chemical deterioration; reduced power consumption; instantaneous record and playback capability; lower replication and distribution cost; high signal-to-noise ratio with low thermal conductivity; and on-the-job training applications. However, there are several disadvantages of the optical disk system.

These disadvantages include a lack of user friendly menus and indexing of data, lack of sophisticated software to integrate the storage system with the mainframe, slow writing and retrieval speed, high cost for error corrections, and a lack of industrial standardization. The disadvantages must be caveated by stating that each of these problems has been eliminated in laboratory tests by current optical disk system manufacturers, as indicated in Chapter Two (under sections Commercial Product Releases, and Optical Disk Predictions) and improved systems will be commercially available by the early 1990s.

Finally, the size and number of MPFs were covered extensively in Chapter Three. The most critical factor for consideration was the total space required for MPF storage. Table 2 indicated the storage space required to support the MPFs was approximately 17.5 billion characters which does not include the archival or backup files. Although these are relatively large files, they are well within the storage capacity of the optical disk system. Consequently, the optical disk system could accommodate HQ AFMPC MPF storage requirements.

SUMMARY

The problems associated with processing MPFs at HQ AFMPC are very complex and a function of many variables. Even though the size and number of MPFs are predicted to stay the same for the next few years, other problems associated with additional MPF users and their current processing procedures loom in the future. The large number of users of APDS-II present the most significant problem. Future computer technology must be explored before the problem becomes insurmountable. Optical disks represent the future, and could provide a solution to the HQ AFMPC problem of extremely high demand for MPF information.

Chapter Five

RECOMMENDATIONS

Based on the documented research, the author has determined that the optical disk system represents the future technology for storage media devices. Growing demands on the HQ AFMPC system warranted research on optical disk computer technology to determine its potential to enhance the personnel system's capability, and to complement the Honeywell systems in this already demanding environment. ~~The author concludes by~~ recommending that HQ AFMPC budget for the acquisition of an optical disk prototype system to further explore the advantages of this type of storage media device to the HQ AFMPC processing environment. This storage media will serve as a supplement to the current Honeywell system.

CONSTRAINTS

This recommendation was based on the analysis of recent educational, business, and science and technology research periodicals. The author was unable to attend computer shows featuring optical disk systems, due to the time and funding constraints of this study. Factoring in the acquisition cost of procuring and supporting an optical disk system was also beyond the scope of this study. These constraints and limitations, although critical for an actual acquisition, did not affect the ability of the researcher to conclude that the optical disk system can accommodate the MPFs.

OPTICAL DISK APPLICATIONS

OTHER SUGGESTED ~~AREAS~~ FOR HQ AFMPC TO PURSUE

The many advantages of the optical disk system lend themselves to numerous other applications and areas that should be explored within HQ AFMPC. For example,

a. Possible replacement for the numerous paper records that are placed on microfilm at HQ AFMPC. This area requires a labor intensive environment for transferring records from paper to microfiche. The use of the optical disk system could reduce or possibly eliminate the manpower requirement for this paper to microfilm transition.

b. Reduction in the space requirements of the storage media computer equipment at HQ AFMPC. This could result in a possible elimination of the bulky off-line storage systems (magnetic tape) and a reduction in the manpower requirements associated with this labor intensive environment.

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